

ARCHEAN LIFE

L8 Archean fossils < stromatolites, bacteria, progenotes; web of life >

What does not destroy me makes me strong. —Friedrich Nietzsche.¹

The world has creatures that ‘breathe’ iron and uranium, using these elements in the same way as we use oxygen. Others thrive in the equivalents of hot sulphuric acid or floor stripper, and others again live in solid rock. —Sean Nee.²

The most obvious fossils of the Archean “slime world”³ are stromatolites. However, not obvious is the sedimentary environment in which these formed as Archean epeiric-sea platform deposits have nowhere been found (except, possibly, for a 10 km strip of nearly continuous outcrop of the 3.43 Gy Strelly Pool Chert, Western Australia, described by Abigail C. Allwood in 2006).⁴ Some Archean “stromatolites” have precipitate-textures that are best explained as entirely chemical. Because the term stromatolite in its common usage does not exclude the latter, the term *microbialite* should be used when biological origin is certain or when a case can be made that the prominent features (layering and shape of these) record the biological involvement of microorganisms.

Existing bacteria are the most successful of all organisms in terms of variety and numbers. From the dearth of bacteria fossilized in stromatolites, where chances of their forms being preserved as fossils would be good as anywhere in carbonate shallow-water facies, we can be confident that, in addition to the stromatolite building bacteria, there were vastly more bacteria species which have left no fossils. This will have been so for as far back as there is a sedimentary rock record.



James William (Bill) Schopf

His 3.5 Gy ‘fossils’ are real he maintained, in 2002, in a debate —“A truly hydro-thermal performance, with more heat than light” said protagonist Martin Brasier whose counter claim is that the same are amorphous graphite artifacts formed out of cooling volcanically-heated submarine-spring water.

However, Schopf’s famous original suggestion that the organisms were likely “oxygen-producing cyanobacteria,” is, he concedes, one he no longer favors.⁶

At the surface of stromatolites, cyanobacteria carry out oxygenic photosynthesis and below this surface are anoxygenic photosynthesizers, and in deepwater muds are a panoply of methanogens that extract energy from oxygenated water and reduced organic debris.⁵

Methanogens could have preceded the evolution of photosynthesis as, before oxygen was abundantly dissolved in seawater, dissolved sulfate for them would have played a weak energizing role. However, if these bacteria existed, the ocean surface waters would likely also have been populated with photosynthetic plankton.

Archean stromatolites, if they are microbialites, are fossil evidence of the existence of microbial mats in shallow coastal waters of volcanic lands.

Today ocean islands, island-arcs, and mid-ocean ridges, are sites where hydrothermal microbial communities flourish far below the level of light penetration and in near boiling water where also massive volcanogenic-sulfides precipitate.⁷ In similar massive sulfides, in 3.2 Gy Archean volcanic rock, threadlike filaments (twining and twisting in different directions) have been described as fossil microorganisms by Birger Rasmussen in 2000.

Microbial fossils occur in some of the oldest rocks that retain sedimentary structures. In the Barberton Greenstone Belt of the Swaziland supergroup, southern Africa, are 3.4 Gy microspheres and 3.3-3.5 Gy stromatolites. In the

Warrawoona Group (granite-greenstone terrane) of the Pilbara supergroup, North Pole (hot desert, Ha, ha!) area, W. Australia, are 3.456 Gy Trendal-locality coniform stromatolites and 3.465 Gy Awramik-locality stromatolites and, between these stratigraphically, the Apex cherts from which **J. William Schopf** in 1993 distinguished (by shape and geometry) species of filamentous microbes.

Archean microbialite glass bioalteration⁸ structures evident in greenstones (volcanics) are 3.3-3.5 Gy at Pilbara, northwestern Australia and at Barberton, eastern South Africa, and 3.7-3.8 Gy at Isua and Akilia, southwest Greenland.

In 2002, re-collected Apex cherts microfossil-like structures⁹ like those that Schopf had offered as evidence of life¹⁰ are reinterpreted by Martin D. Brasier¹¹ as secondary artifacts formed from amorphous graphite within multiple generations of metalliferous hydrothermal vein chert and volcanic glass. Also in 2003, from both abiotic and inorganic sources, J. M. García-Ruiz with others have synthesized organic hydrocarbon filaments that are morphologically identical to supposed cyanobacterial microfossils obtained from the Apex cherts.¹² Stephen Moorbath regrettably nixes all proffered finds (to the year 2005) of life's fossils older than those of bacteria in the 1.9 Gy Gunflint Formation of Ontario.¹³ In 2006, Allwood nixes that, having found an example of Archean "stromatolites" in a (small) carbonate platform environment (recall above).¹⁴

Web of life

The existence of cyanobacteria (photosynthesizing organisms) that make their building materials from carbon dioxide, dissolved mineral salts, and light, implies long prior evolution. (The smallest extant cyanobacterium is abundant *Prochlorococcus marinus* with 1,884 genes for making proteins and 40 genes for making transfer RNA.) How much time for their appearance would be needed? (Three and a half billion years ago is one billion years after the beginning of Earth as a solid body).

All organisms must be able to transmit genes vertically (from parent to progeny), however horizontal- (or, what is the same, lateral-) gene transfer is common for: bacteria to bacteria, bacteria to plant (as gall-tumors exhibit),¹⁵ and retro-viruses to all. Bacterial genes consist of strings of the four nucleotide bases: A, T, C, and G. The proportions of these bases differ between species. For example, G and C represent 52 percent of the bases in *E. coli* DNA but the GC content of other bacteria ranges from 25 to 75 percent. "Molecular archaeology" is to scan a genome for DNA regions where GC content diverges from the bacterium's norm. By this method, Jeffrey G. Lawrence and Howard Ochman found that 755 of *E. coli*'s 4,288 genes were introduced into the bacterium from other microbes in the 100 million years since it diverged from the lineage it shares with *Salmonella*.

Genes can be distinguished as either informational or operational.

Informational genes typically encode molecules that play a role in converting the information encoded within DNA into a protein. The products of informational genes, such as ribosomal subunits, often must work in concert with many other proteins to perform their task. As a result, they (like ribosome itself) consist of dozens of molecules.

Operational genes encode proteins involved in the upkeep of the cell. Many, such as an enzyme that destroys a misfolded protein, may need to interact with just one other molecule.

A complexity hypothesis proposed by James A. Lake is that informational genes (the products of which interact with many other molecules) are less likely to transfer successfully between microbes than are operational genes (the products of which have limited contact with other molecules).

Carl Woese, who first found for archaea their separate branch on the evolutionary tree, in 1998 proposed that Earth's earliest life forms were cells with genetic mechanisms too simple to include barriers to lateral exchange. These "progenotes" (term coined by Freeman Dyson)¹⁶ shared a communal genome (and so are not "species" per se) rather than a fixed one for each cell.¹⁷ Rampant gene sharing then could have enabled rapid web of life¹⁸ evolution that "evolved in a lamarckian way, with vertical descent marginalized by the more powerful early forms of horizontal gene transfer."¹⁹

